CONTRIBUTIONS OF B-LEARNING IN THE TEACHING OF MATHEMATICS IN ENGINEERING: AN EFFECTIVE SHARED RESPONSIBILITY OF STUDENTS

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Resumo

O paradigma emanado pela Declaração de Bolonha, ao centrar no aluno o processo ensino/aprendizagem, faz emergir a necessidade de convergir a aplicação de estratégias de informação e de modelos de comunicação aos interesses, motivações e estilos de aprendizagem dos alunos para que as mudanças de atitude e de comportamento face ao ensino revertam em aprendizagens mais significativas e, por conseguinte, conduzam a um maior sucesso escolar.
É universalmente aceite, e consubstanciado por estudos científicos, que as tecnologias de informação e comunicação (TIC) têm permitido a construção de um conjunto de instrumentos de suporte que complementa o ensino presencial e que permite aos seus utilizadores uma maior interação e facilidade na comunicação, traduzindo-se por conseguinte, num maior envolvimento dos alunos nos processos de aprendizagem.
O correio eletrónico, a Internet, as plataformas virtuais MOODLE e outras ferramentas de comunicação, são considerados como fatores diferenciadores nas formas organizacionais relativas aos métodos de ensino tradicionais, pelo que recurso à sua utilização tem vindo a ser cada vez mais incrementado, exigindo aos docentes uma transformação contínua nos seus modelos de ensino.
É neste contexto e considerando os elevados índices de reprovação e de abandono no ensino superior, nomeadamente nas unidades curriculares de Matemática ministradas nas licenciaturas de Engenharia, que se levou a efeito um estudo exploratório que pretende efetuar a análise dos comportamentos dos alunos perante a utilização das TIC como estratégia de apoio pedagógico, por forma a contribuir para a construção de um ambiente de aprendizagem que permita uma coresponsabilização dos alunos no processo educativo e que possa estar relacionado com o sucesso escolar.

Palavras-chave: B-learning, Matemática, Moodle, Engenharia.

Abstract

The paradigm stemming from the Bologna Declaration, by putting on the student the focus of the teaching/learning process, brings out the need to converge the implementation of strategies for information and communication models to the interests, motivations and learning styles of students so that changes attitude and

behavior towards teaching revert in a more meaningful learning and therefore lead to greater academic success.
It is widely accepted and corroborated by scientific studies that the information and communication technologies (ICT) have allowed the construction of a support tools set that complements classroom teaching and allows its users a greater interaction and ease of communication, rendering a greater involvement of students in the learning process.
The e-mail, the Internet, virtual platforms such as MOODLE and other communication tools are considered as factors in differentiating organizational forms relating to traditional teaching methods, so that recourse to its use has been increasingly enhanced, requiring teachers a continuous transformation in teaching models.
This context, and considering the high failure and dropout rates in higher education, including mathematics courses taught in undergraduate engineering, has carried out an exploratory study that aims to contribute to build a learning environment that allows shared responsibility of students in the educational process.

Keywords: B-learning, Mathematics, Moodle, Engineering.

1. INTRODUCTION

The quality of learning in higher education emerged in the reflection of the scientific community as a problem arising from a further deepening of democratic systems around the 90's. Consequently, we are witnessing a growing number of students attending this level of education that show a variety of personal and motivational characteristics. No less important, the policies of higher education access in Portugal, as exemplified by the regime aimed at those over 23 years old, or students from the professional and technological courses, brought new challenges to the university and polytechnic institutions, requiring them an ability to adjust its spaces, making them more attractive and competitive and able to motivate an heterogeneous audience as a result of their needs and expectations.

Additionally, the paradigm stemming from the Bologna Declaration admits a change assumption: to replace a teacher-centered transmission of knowledge model by a learner-centered model and the construction of knowledge by assigning significance to it. Thus, it is accepted that in addition to the acquisition of knowledge, the training component becomes part of stimulating the development of personal and professional skills that enable students to better adjust to the flexibility, complexity and adaptability in different life contexts.

In addition to these challenges, caused by the natural consequences of structural changes in the educational system, it is widely accepted that the information and communication technologies play a fundamental role in this reorganization, as a complement of student learning, both in terms of access and ease dissemination of information and in the development of new contexts for their achievement. It is widely recognized and corroborated by scientific studies, that the information and communication technologies have allowed the construction of a set of support tools that complements classroom teaching and allows its users a greater interaction and ease of communication, rendering a greater involvement of students in the learning process - "The introduction of computers in education is seen as particularly susceptible to enrich teacher's pedagogical strategies and stimulate in various educational contexts, methodologies that encourage activity, participation, collaboration, initiative, creativity ..." (Ponte, J., 1994). The e-mail, the Internet, the virtual platforms such as MOODLE and other communication tools are considered to be differentiating factors in organizational forms with respect to traditional teaching methods, so the recourse to its use has been increasingly enhanced, by requiring teachers to be in a continuously changing teaching model. In this sense, taking into account the emerging public in higher education, the use of ICT represents extra value to the teaching/learning process, particularly with regard to the flexibility and access, making the physical presence and movement requirements not mandatory for the monitoring of the material, the improvement of communication channels and the increase in collaborative work, which are critical engines of a more and more frequent interaction in the current job market.

No less important, due to the continuous determination in developing the higher education quality of training it is given an intensified attention to school failure, making the promotion of success a fundamental objective of the institutions' action. In the last decade, although many studies have been seeking to understand the reality of academic failure in higher education, leading to investigations that seek to know, in depth, how learning takes place in students' level of education, some analysis on the relationship between teaching methods and how students learn (Grácio et al, 2005)

need to be developed. On the other hand it is important to contextualize these concerns particularly in the case of teaching and learning mathematics. The authors, mathematics teachers in the various degree courses taught at the Instituto Superior de Engenharia de Coimbra, are confronted with an increasing lack of motivation, uninterested and consequent neglect of students in relation to the mathematic courses. This situation, compounded by the difficulty shown by students in elementary and basic concepts, essential to successful integration in the syllabus, inevitably leads to high failure rates and subsequent concern of the teachers.

In this new environment of teaching/learning arises a greater demand for higher education teaching, higher criticism, a further reflection on their teaching practice and a constant adjustment of the educational courses difficulties to particular characteristics of their students in respect to the meaningful construction of knowledge. By focusing the teaching/learning process on the student, there emerges the need of implementing these strategies, for dissemination of information and communication models to the interests, motivations and learning styles of students, I order to have changes in attitude and behavior towards school that revert the learning more meaningful and therefore lead to greater academic success.

However, any learning environment can be considered as a unique and unrepeatable space built by teacher, based on their views on the educational process and mastery of its knowledge, in particular in relation with the use of ICT, continuously adjustable to the interaction between its actors (Marin, 2009).

It is under these assumptions that the present work arises and discusses an exploratory study that aims to carry out the analysis of students perceptions of the introduction of ICT as a teaching strategy that contributes to support the construction of a virtual learning environment, allowing a shared responsibility of students in the educational process and that may be related to school success.

2. B-LEARNING IN HIGHER EDUCATION

Students who access the Instituto Superior de Engenharia de Coimbra (RAC-SA, 2010) have very different characteristics, both at the origin (on average 60% of students

placed on engineering degrees do not come from the district of Coimbra) and in respect of their basic academic training (for illustrative purposes, it appears that the majority of students engaged, approximately 63%, are from the science and technology courses, but this number is decreasing over the years, giving rise to a greater distribution in the remaining variants of courses).

Considering this diverse audience and the need to offer more flexible ways of learning, ISEC and in particular the Physics and Mathematics Department has encouraged the adoption of a distance component of b-learning (- Blended learning platform - in use for the last eight years). The "LVM- Virtual Laboratory of Mathematics" (http://lvm.isec.pt/) is based on an e-learning platform (MOODLE) and it is a complement to classroom learning that welcomes all mathematic courses taught in the engineering degree at the ISEC.

Fig. 1: LVM- Virtual Laboratory of Mathematics

In an approach that aims primarily to enable the access to the content and provide a way, beyond the space of the classroom, so that teachers and students interact and communicate with each other, this environment has proven to be a good solution as a teaching/learning strategy, also contributing as an opportunity for a more active involvement in the educational process.

In order to enhance the functionality of this platform, viewing it as stimulating interaction and experimentation through the technological resources, it is important to reflect on the integration of ICT as a promoter of students' meaningful learning that may revert into academic success. Since 2009 it has been developed a survey that

includes several case studies which are aimed to know, in more detail, the implications of ICT's use in educational practices applied in some mathematic courses taught in undergraduate engineering at ISEC. By analyzing the behavior of students on the implementation of that strategy to support teaching, we want to reflect on teaching practices and question what learning environments allow a joint responsibility of students, in the educational process, and may be related to better learning. This exploratory study (Bigotte, E., 2010), is integrated into the design of research-action "Understand learning to better teach" which the authors develop in the activities of the research group GIDiMatE – Grupo de Investigação em Didática da Matemática na Engenharia.

2.1 The methodology

The research follows a qualitative research methodology, considering the observation of several specific cases, that allows us to understand and explain holistically and in a building perspective, as suggested by Stake (Stake, R., 1998), the virtual learning environment phenomena, using the MOODLE platform through "*LVM*-Virtual Laboratory of Mathematics", intending to get explanations to the questions posed:

Q1: What behaviors show students using "*LVM*-Virtual Laboratory of Mathematics"?

Q2: What is the student's profile, who interacts in the activities undertaken by "*LVM*-Virtual Laboratory of Mathematics"?

Q3: What virtual environments for teaching/learning enable a shared responsibility of students in the educational process?

2.2 The sample

The sample consists of 50 students who gather the conditions for admission to assessment of Mathematical Analysis course degree in Computer Science Engineering, functioning in the second semester of the first year, in a sliding mode, in the academic year 2010/2011. This functioning extraordinary regime operation arises from an attempt to overcome the failure detected over the years, in mathematic courses, taught in first year. In fact, the Mathematic Scientific Committee of ISEC implemented,

in 20010/2011, the pedagogical experience "Sliding Courses" which after analysis and corrections made in order to optimize resources and improve results, was included in the teaching service, on the following assumptions:

- slider courses work in alternative semesters, in addition to the undergraduate curriculum;
- the universe of addressed students is all students that have not been approved in the previous semester;
- only students who have attended a minimum of 60% of all classes (theoretical, theoretical-practical and practical) are allowed to take the exam. This condition does not apply to students who have approved Elementary Mathematic course, in the first semester (of the corresponding school year), or students covered by Law 105/2009 of 14 September 2009 (employed students).

Students engaged in Computer Science Engineering have a great diversity in their basic training, with mathematics access grades ranging from 12 to 18 (out of 20), and are may have fit in difficulties into content taught in higher education. They often show a position of very high absenteeism at school, revealing irregular effort in the classroom or in carrying out learning activities proposed by the teacher.

In order to establish the student's profile, other data sample was collected, among the first year students of Computer Science Engineering by fulfilling a questionnaire regarding their ICT behavior.

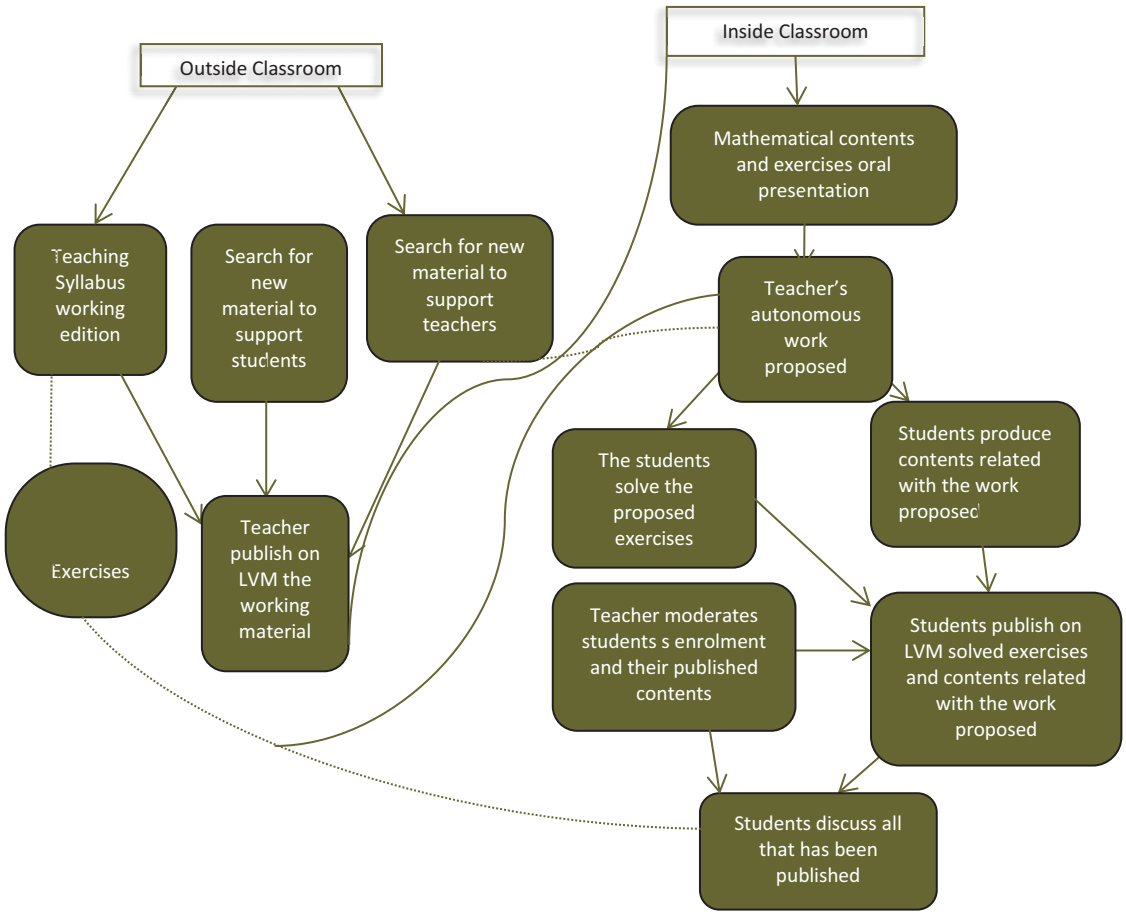
2.3 Description of the learning environment

The teacher responsible for the course that will be focused in this exploratory study is also an involved researcher who has, over the years, reflected on her teaching practice and questioned herself about what teaching and learning strategies best fit students as an attempt to make learning more meaningful, and result in effective school success. Behind the present study, lies a motivation to understand the practices and learn how to improve them from the conclusions. This study aims the introduction of changes in the learning environment used in this context that encourages the formulation of working hypotheses to be further tested in other investigations.

In the classroom, given the nature of the syllabus covered, the teacher used the theoretical classes for introductory explanation of subjects, with exemplification through problem solving for the acquisition of basic knowledge, while in the remaining classes (theoretical-practical and practical) other teaching methods were applied and shared resolution of exercises led to the understanding and application of materials. Specific activities were proposed to create in students the spirit of synthesis and analysis necessary to obtain the desired learning outcomes.

In an attempt to complement the classroom with a virtual learning environment, the strategy of ICT integration was considered in a perspective of teaching support, both pedagogical (content publishing, dissemination of materials and miscellaneous items) and administrative (dissemination of warnings and other information, display of patterns of results, booking of additional classes). The use of the referred complement was promoted throughout the semester by students, as can be seen in detail in Figure 2.

Fig. 2: Strategies to integrate ICT



All materials necessary for each chapter (hand-outs and exercise sheets) were previously placed on the platform. The work published by the students in LVM and discussed among peers, was monitored by the teacher, thus allowing, further monitoring of issues and contribute simultaneously to improve the communication channels and encourage cooperation.

Other activities were also set up by sending advanced files to correct and integrated the process of individual formative assessment.

The adopted setting was the topic format. Five topics have been established, corresponding to each syllabus chapter (revisions, primitives, integral calculus, improper integrals and differential equations). In order to promote the application of constructive teaching methodologies and enhance ICT in a laboratory learning environment the use of computer algebra software was also available in a LVM link to GeoGebra.

The notes to support lectures, basic texts written by other teacher (course non lecturer) and worksheets that were proposed by the teacher, was posted in the general topic, space where it has been also proposed five thematic forums (revisions, primitives, integral calculus, improper integrals and differential equations) that aimed to achieve the interaction between peers and between students and teachers, through the exchange of messages, questions, the presentation of various forms of exercises proposed solutions and also sharing lecture notes for each syllabus unit. We also built four activities which resulted in individual work for correction.

These shared spaces were launched simultaneously with the introduction of subject exposure in the theoretical classes and had the goal of an autonomous dynamic performed by students, always associated with a monitoring done by the teacher, whose interventions were carried out as an addition to the comments and posts made by students.

2.4 Instruments for data collection

In order to answer the questions Q1 and Q2, in this investigation we used the data collected on the MOODLE platform, regarding the activity reports of each participant included in the sample. For this purpose, it was built a grid with the relevant information to the study and recorded the number of hits per item classification (Figure 3). The following categories were considered:

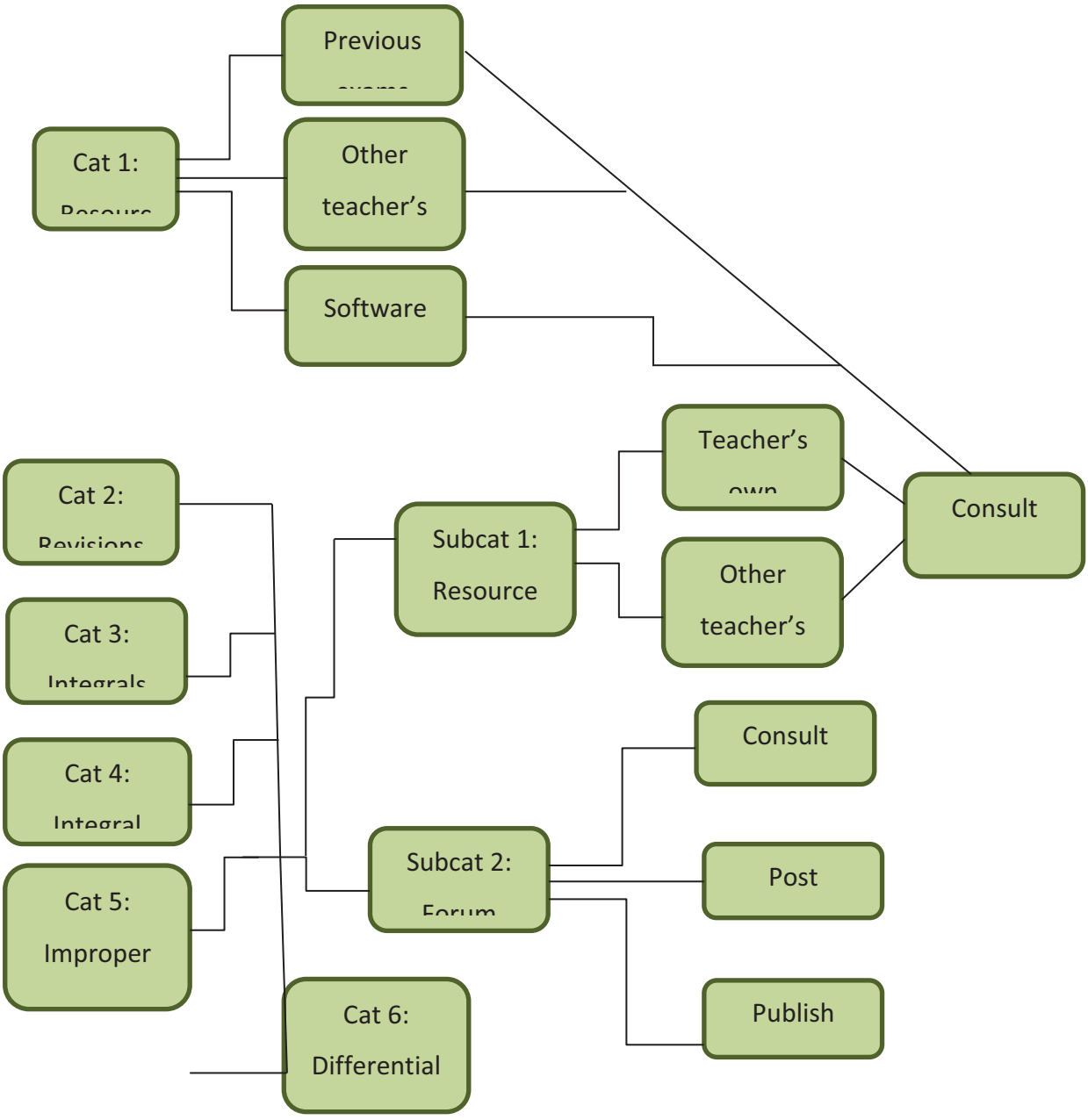
CAT 1-Material resources: integrating the set of tests/exams from previous years, the hand-outs designed by another teacher and a link to external software application (GeoGebra);

CAT 2-6-Revisions, primitives, integral calculus, improper integrals and differential equations which were divided into two subcategories:

SUBCAT 1-Material resources: which includes the set of working sheets developed by the teacher, by desired level of learning outcome and supporting texts provided by teachers not involved in this course;

SUBCAT2-Thematic forums: including comments and posted activities and self-study material.

Fig. 3: ICT categories considered



In order to examine students perceptions regarding the use of ICT, that allows a deep reflection on the construction of virtual environments for teaching/learning, permitting a joint responsibility of students in the educational process (Q3), was handed a questionnaire designed to collect information on four groups of questions concerning:

- students characterization regarding ICT access (five items, e.g.: Do you have access to a computer?; Do you have internet access?)-group A;
- students perception about the importance of ICT use for learning (four items, e g.: in the exposition of the contents, when using software adapted to the syllabus content)-group B;
- how students use the Internet in their learning process (five items, e.g.: talk about problem-solving in forums, exchange of support materials)-group C;
- the use of LVM/Moodle in the learning process (six items, e.g.: to consult notices/information, consult proposed discussion forums)-group D;
- the use of software custom-made to the syllabus (four items, e.g.: problem solving, troubleshooting check)- group E;

It has been used a Likert type scale format, with four points, depending on the degree of students agreement, including an extra option - not applicable.

The questionnaire was run online for students who have attended classes and only those who met conditions for assessment access have been studied. In order to develop further studies in the context of individual attitudes and students behaviors, allowing a greater track knowledge made by each one. Their identification was requested on a voluntary basis, with confidentiality and non-dissemination of data warranties.

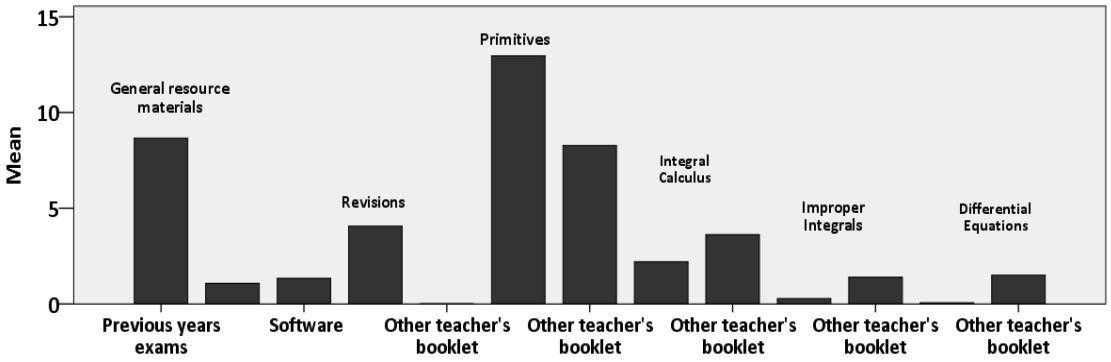
3. **DATA ANALYSIS**

The software used in data analysis was SPSS.

For behaviors evidenced by students in the use of "LVM-Virtual Laboratory of Mathematics" (Q1), it was found that the highest average number of accesses to the platform per considered item (category and sub-categories), was verified at Primitives, in consultation of resources material provided by the teacher of the course (worksheets prepared by the level of learning desired result) complemented with other materials given by teachers outside the course and the explanation of the thematic unit Tests syllabus of previous years was also a teaching tool widely used by students.

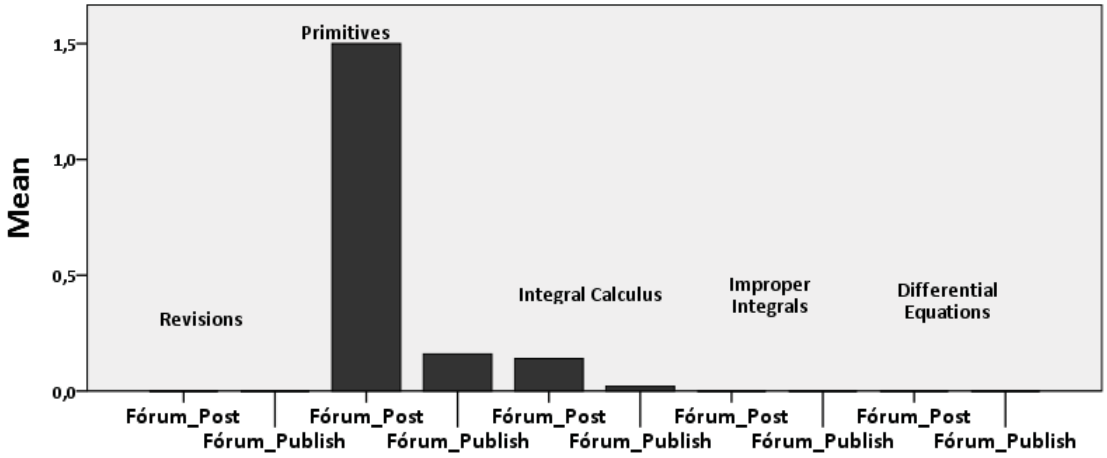
One should take into account the decrease in access to the platform during the semester, evidencing a drop in study methods and monitoring the subject, feature found by the course teacher, by virtue of her experience in teaching Computer Science Engineering students. This is confirmed by the discrepancy between the accesses to the working exercises sheets proposed by the teacher, which leads to an autonomous work and to the material resources that allow contents reading taught in the lectures. (Fig. 4)

Fig. 4: Accesses to general resource materials



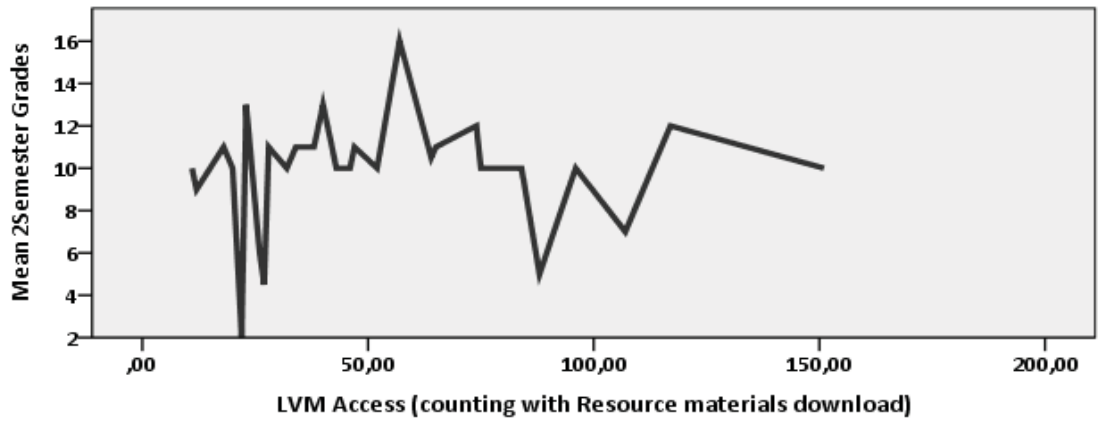
With regard to how students followed the thematic forums launched at the initiative of the teacher, it was found that 18 students participated in comments' post, and only five have posted activities. This contribution tends to decrease drastically to no action in forums with respect to improper integrals and differential equations; indeed, in the forum dedicated to the integral calculus only 7 students performed the posting of comments, registering only one student that have posted study resources. This behavior indicates absence of share culture to knowledge construction and no collaboration among peers (Fig. 5).

Fig. 5: Access to thematic forums



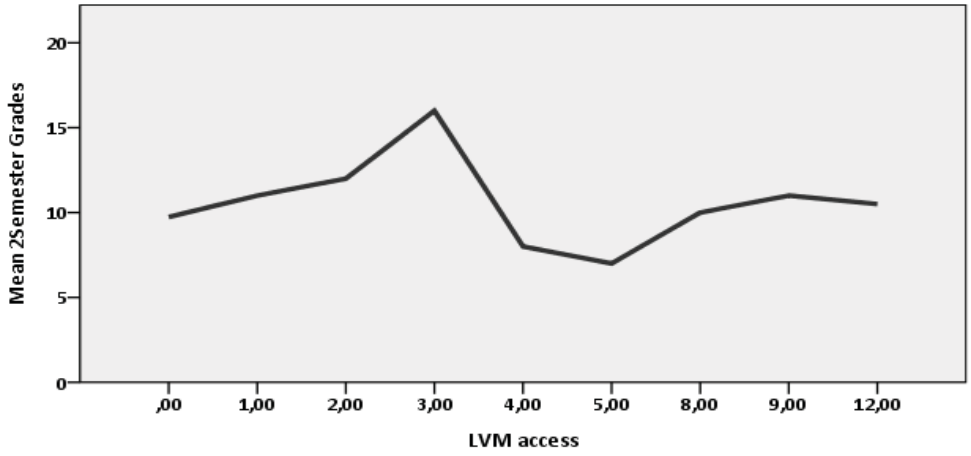
Observing the LVM platform accesses it is clear that, in general, there is not a positive influence on grades, i.e., the students who accessed more to LVM (counting with resource materials consult/download) are not the ones with higher grades (Fig. 6).

Fig. 6: Relation between 2nd Semester Grades and Mean LVM Accesses



Although, if we consider only the accesses, not counting with teaching syllabus, that is the ones that really show interaction between teachers and colleagues, then we may be able to sustain the hypothesis that virtual learning and discussing improves success and may be a cause of higher grades as we can see below (Fig. 7).

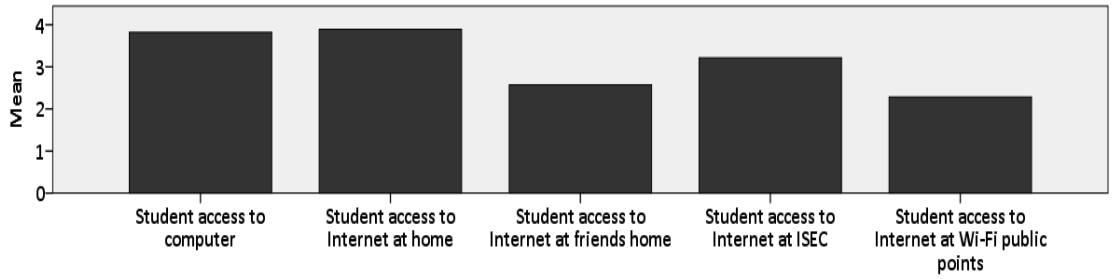
Fig. 7: Relation between 2nd Semester Grades and Mean LVM/Moodle accesses



To better understand which virtual teaching/learning environments allow a higher student's enrolment we performed the data analysis collected via the questionnaire mentioned above (only 38 out of 50 students answered the questionnaire).

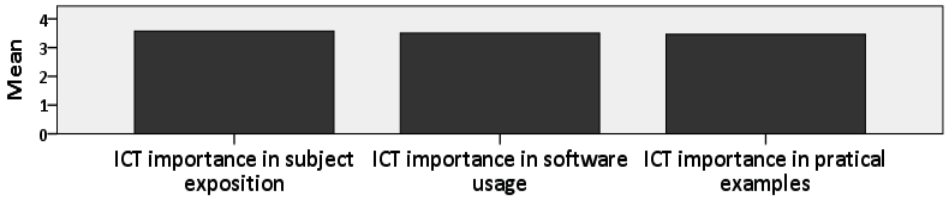
A relevant conclusion is that almost all students have access to the computer, being at home that more students use the Internet. It is given a smaller importance to Internet accesses at public Wi-Fi free places (Fig. 8).

Fig. 8: Students characterization in access to ICT - Group A



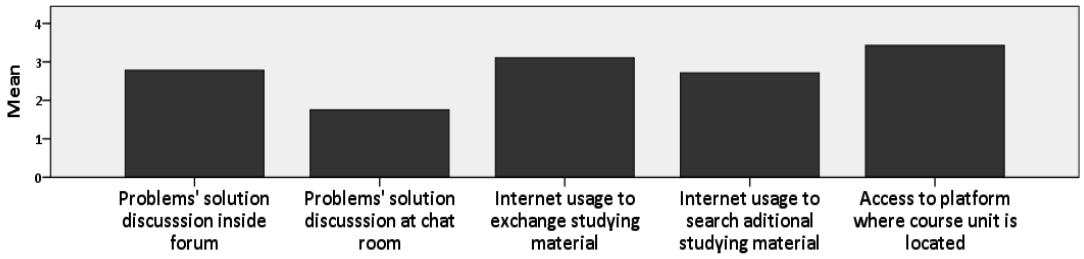
Students confer similar levels of importance when considering ICT as a learning resource: in the context of exposition area, use of software custom-made to the syllabus and the exemplification of practical cases of application (Fig. 9).

Fig. 9: Student's perception about the importance of ICT use for learning - Group B



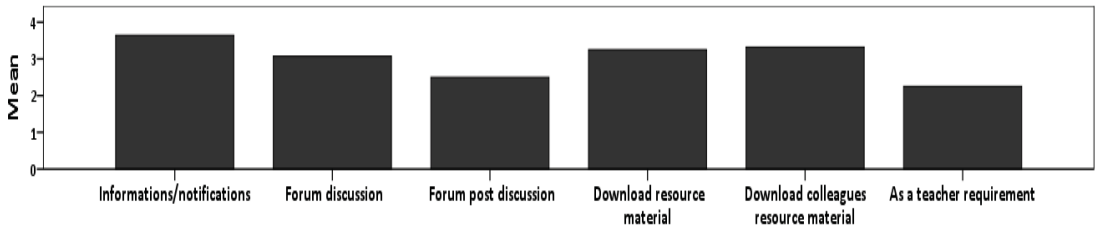
When confronted with the use of the Internet in the personal learning, students consider the MOODLE platform course as the most important feature to be noted and also give some importance to discussion of problem solving in chat rooms (Fig. 10).

Fig. 10: How students use the internet in their learning process - Group C



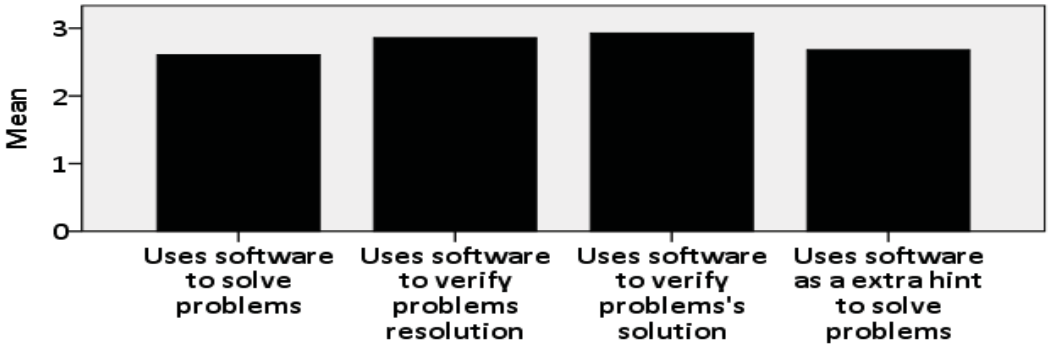
The LVM-platform MOODLE is used in the individual learning process as an important space to consult information and warnings. The discussion forums and the teachers' requirements were not properly valued (Fig. 11).

Fig. 11: The use of LVM/Moodle in the learning process - Group D



Students use the software custom-made program content primarily for checking the problems' solution solved, assigning little relevance to its application in the resolution itself (Fig. 12).

Fig. 12: The use of software tailored to the syllabus - Group E



4. **CONCLUSIONS**

The poor adherence to the proposed publication of material developed in class was clear, confirming the results of the academic year 2009/2010 (Bigotte, E., 2011), which shows no culture of sharing to build knowledge, or collaboration with colleagues. It seems reasonable to assume that student's participation in discussion forums encouraged interaction between teacher and students and contents lectured.

Of the five chapters covered in the Course (Revisions, Primitives, Integral Calculus, Improper Integrals, Differential Equations) five discussion forums for worksheets resolution were created by the teacher. The second forum (Primitives) was the one that students were most enrolled in.

The intervention decreased along the semester, and there was no participation in the last two forums. This behavior suggests the need to introduce diversified strategies in order to create internal and/or external stimulation to remain discussion forums active.

There were no evidences both in terms of the relationship between the student who uses more frequently the LVM platform and achieving better final grades. This conclusion leads to further studies to allow better cross information, filtering it to the

level of individual trajectories of students in order to be able to establish correlations and draw a profile of student's activities that interacts in the "LVM-Virtual Laboratory Mathematics ".

It also follows that, with respect to virtual environments for teaching/learning definition that allow students shared responsibility in the educational process, questionnaires answers showed that students consider the MOODLE platform as an important source of information/material resource recollection, necessary for the operation of the course by the teacher or peer's sharing, but do not appreciate it as a strategy for autonomous learning, not taking it as a provider of knowledge construction through interaction between peers or with the teaching and also do not consider the publication of their own reviews or studying materials.

It is worth mention that, since there was not any type of pressure by the course teacher that induced a "requirement" in the use of the LVM platform in student's learning process, the suggestion is that this type of participation may eventually be included as component in the formative evaluation parameters.

The use of educational software syllabus tailored was considered medium relevant towards its application to problem solving, solution's verification and acquisition of relevant technical suggestions for its implementation.

The Internet was not accepted as an important space for interaction and research of complementary expertise.

For the social presence, directly related to the ability of each student project through this virtual environment, either by the characteristics of his temperament, or by the ones associated to their knowledge, we concluded that all accessed regularly to the material available, although not participating in the forums.

In terms of ICT strategy applied there was a significant intervention by the student throughout the learning process, reflecting primarily the simplification of access to the support content classes. Regarding the specificity of the course, the study showed the need to create a more flexible intervention concerning the learning rate of the individual pupil, and allows for a more individualized monitoring, the requirement for building dynamic learning objects, that can be easily updated and adjusted to each

context and creating an environment that promotes group cohesion, and help to ensure the social presence of all stakeholders.

This contribution will be essential to a participatory and careful reflection of the pedagogical practice in higher education and is intended that its conclusions come to reverberate themselves in the dynamic of integration of the ICT allowing, over all, an eventual modification of the ideas and an improvement of teacher's professional performance.

It is intended that changes of attitude and behavior of the pupils face to the school revert in more significant learning and therefore lead to a higher success and it is necessary to converge the application of information strategies and models of communication to the interests, to the motivation and student's learning styles currently attending the higher school.

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